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No. 2

PINK BOLLWORM INFORMATION

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U.S. DEPARTMENT OF AGRICULTURE

COOPERATIVE RESEARCH ON THE PINK BOLLWORM AND RELATED COTTON INSECTS

Distributed occasionally by
the Pink Bollworm Research Center,
Brownsville, Texas

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PINK BOLLWORM INFORMATION

NO. 2

HIGHLIGHTS

Louisiana has joined Alabama, Arkansas, Georgia, Mississippi, and Texas in contributing funds for pink bollworm research.

The bioclimatic building has been insulated and made insect-proof so that the pink bollworm and Mexican fruitfly can be handled safely therein.

A number of meetings relating to cotton have been attended by members of the staff and numerous talks have been presented and papers have been published to help keep various branches of the cotton industry and others informed of progress.

Dr. Sloan E. Jones has been appointed by the U. S. Department of Agriculture as administrative and technical director of pink bollworm research for which the Cotton Insect Section is responsible. Dr. C. H. Tsao has been appointed by the U. S. Department of Agriculture and assigned to the insect toxicology project.

Bloom and boll inspections indicated rather heavy pink bollworm carry-over in the Winter Garden area and in central Texas, especially between Austin and Waco. One larva was found in De Baca County, New Mexico, the most northern point where bloom infestation was observed. Infestation in the Lower Rio Grande Valley was considerably lower than in 1953. A few pink bollworms were found in southwestern Louisiana and three in De Soto Parish, Louisiana. Gin trash crews in Georgia, Florida, and Mississippi turned up no infestations. The cutting and shredding of cotton stalks in south Texas was essentially complete on the deadline dates. In the Matamoros section of Mexico, where stalks are supposed to be destroyed on August 31, there was a delay on about 10 percent of the acreage due to some late plantings and rain. At date of issue much trouble is being experienced from heavy growth of volunteer seedling cotton and failure to get the few remaining stalks plowed out due to rain. An experimental stalk shredder developed by the Texas Agricultural Experiment Station showed promise for killing pink bollworms in the shredding operation. Tests were also conducted with two commercial shredders that had been modified to increase the larval kill.

Pink bollworm infestations in the Lower Rio Grande Valley were generally too light to show marked results from the use of insecticides. In insecticide experiments, small to moderate gains in cotton yield were obtained from control of the boll weevil. Mixtures of DDT and methyl parathion and of DDT, endrin, and methyl parathion show promise for the control of the principal cotton insects. The former, however, does not satisfactorily handle a heavy boll weevil population after migration has begun. A combination of DDT, dieldrin, and methyl parathion or parathion gave satisfactory control of all the main cotton insects. There was no appreciable difference in boll weevil or aphid control obtained with BHC-DDT dusts containing 3 percent gamma formulated from high or low gamma BHC or a commercial dust containing 5 percent gamma BHC. Compound 12,008 looked promising as a systemic insecticide for aphids when applied as a seed treatment.

Fumigation of okra with 1 to 1½ pounds of methyl bromide per 1,000 cubic feet was found to give 100 percent kill of pink bollworm eggs.

Five of the most promising parasites and one predator, originally imported from India, were reared in numbers totaling 377,000 adults which were liberated in 15 south Texas counties and in Tamaulipas, Mexico. No recoveries of these were made in a number of collections subsequent to their release.

Hibernation tests carried out in 7 localities in Texas and 1 in Oklahoma confirmed the results of the previous winter in that the insect can successfully overwinter as far north and east as Chickasha, Oklahoma and Mount Pleasant, Texas and on the Plains at Lubbock, Texas. They showed fall burial to be the preferred practice for reducing survival and that leaving infested bolls on the soil surface causes the highest winter carry-over. Few moths are produced to infest the next year's crop in the Rio Grande Valley if the stalks are destroyed on August 31. The peak of moth emergence in these hibernation tests occurred in the 8 localities during the weeks indicated below:

Brownsville, May 1	Mount Pleasant, June 5
Port Lavaca, May 22	Lubbock, June 19
Waco, June 12	Vernon, June 12
Greenville, May 29	Chickasha, June 12

Four plant species were found to serve as pink bollworm hosts that were not previously known. This makes a total of 29 plants other than cotton in which the insect can develop in the United States.

Qualitative analysis of haemolymph taken from non-resting fourth stage larvae showed 23 amino acids and 2 peptides to be present. Cotton-seed meal or peanut meal with yeast and water have been found to be satisfactory media for rearing pink bollworm larvae. A technique for rearing these insects in large numbers has not yet been developed.

Tests were conducted at a number of commercial gins to determine the kill of pink bollworms in the seed and gin trash after the infested seed cotton was put through the gin and a single trash fan. In some tests only 0.8 percent of the larvae entering the gin in seed cotton produced moths when the seed was caged. Gin trash from heavily infested seed cotton was passed through a conventional trash fan as a continuous part of the ginning operation in 37 tests involving 21 gins. Hand examination of 37 pounds of this trash revealed no live larvae and only 2 moths emerged from each of 2 50-pound caged samples from gins equipped with No. 30 fans and none from those with larger fans. Pink bollworm infested cottonseed was put through the standard oil mill process at Lubbock. Twenty-six percent of the larvae survived the first delinting process and 1.8 percent survived the second delinting. Large numbers of live larvae were found in the shaker waste. Some living larvae were found in motes that had not passed through the mote beater, but none after passing through that equipment. No live worms were found in linters, lint beater waste, or in seed hulls or meats.

Studies of the biology of the pink bollworm at Brownsville have supplied exact information on the development and habits of the insect under different conditions and on factors influencing the production of long-cycle larvae. Of the 3,204 larvae observed during these studies, 58.8 percent were females. Seventy-five percent of the moths emerged during the period, 5:00 - 7:00 a.m.; 90 percent of the eggs were laid between 8:00 p.m. and midnight. The incubation period ranged from $3\frac{1}{2}$ to $15\frac{1}{2}$ days according to temperature. The period from hatching to adult required 20 to 21 days in squares, and about 28 days in bolls. The pupal period ranged from 7 to 33 days depending on temperature, larval food, and sex, averaging about 8 days under favorable conditions.

Airplane collections made during the period, August 18 to September 3, showed that 12 moths were caught at various heights from 100 to 1,000 feet; none at 5,000 feet. One of these was taken at 1,000 feet over the King Ranch about 15 miles from the nearest cotton. In a light trap on the El Jardin Hotel, 100 feet above the ground, 149 moths were captured.

Traps equipped with lights in the ultraviolet band were operated in many localities and served to indicate moth presence and abundance. Traps set at heights of 2, 4, 6, 8, 10, 12, and 14 feet above ground showed the lower traps to catch by far the larger number of moths. In this test 23,929 moths were caught and of these 81 percent were males. In one trap, emptied each hour throughout the night for a week, 7,973 moths were caught. Of these 67 percent were males, and 41 percent of the total were taken between 2:00 a.m. and 4:00 a.m. Experiments to determine the control value of traps indicated no benefit when one or two traps were used per field. One trap operated in a cage covering 1/20 acre of cotton did not prevent the development of a 100 percent infestation.

P I N K B O L L W O R M I N F O R M A T I O N

Introduction: This is the second of a series of information circulars designed to inform interested State Experiment Station Directors and other officials and workers directly concerned with the pink bollworm problem of the status of the insect and of progress on research underway. The first of these circulars was issued on May 26, 1954. We trust that you have retained that number as it contains background information which will not be repeated herein. In order to orient the reader in some of the fields of research, certain of the findings prior to the date of issue of the last circular (May 26) will be referred to.

Although no spectacular discoveries have been made, progress has been steady and reasonably satisfactory. Research results come slowly. This is especially true of a complex problem like the control of the pink bollworm - an insect with which it is difficult to work. One of the problems before us is to keep the growers and others involved in the cotton industry from becoming impatient because of the time consumed in obtaining conclusive results. This might adversely affect their cooperation and support of research or to cause them to make serious mistakes by prematurely adopting methods suggested by work underway.

Financial Support: Mississippi has now joined in the coordinated research program. The legislature of that State appropriated $25,000 per annum for a two-year period, effective July 1, 1954. The Louisiana legislature appropriated $5,000 for the fiscal year beginning September 1, and $10,000 for the subsequent year.

Funds provided by various agencies are as follows:

Entomology Research Branch, Agricultural Research Service, U. S. Department of Agriculture (including Washington, D. C. overhead and work at Brownsville, Port Lavaca, Lubbock, College Station, Waco, and Torreon, Mexico. Available July 1, 1954). $177,245

Alabama State Experiment Station 15,000
($15,000 for each of two years beginning October 1, 1953. One man assigned to Brownsville and with $4,890 for operating expenses and $4,890 added directly to Research Center budget through the U. S. Department of Agriculture).

Arkansas State Experiment Station 15,000
($15,000 for each of two years beginning July 1, 1953. One man assigned to Port Lavaca major part of year with another on a seasonal basis, and part of cost of hibernation tests at Mount Pleasant; approximately $7,500 spent directly on the pink bollworm in Texas).

Georgia State Experiment Station 15,000
($15,000 per year for two years beginning July 1, 1953. Funds made available to the Pink Bollworm Research Center through the U. S. Department of Agriculture).

Louisiana State Experiment Station 5,000
(An appropriation for one year beginning September 1, 1954 and $10,000 for the second year. Presumably one man will be assigned for work at the Center).

Mississippi State Experiment Station ..... $ 25,000
(Biennial appropriation $25,000 per year for two years beginning July 1, 1954. Funds made available to the Center through the U. S. Department of Agriculture).

Texas State Experiment Station 32,000
(Biennial appropriation of $32,000 per year for two years beginning September 1, 1953. Funds expended by the State Experiment Station on certain phases of the coordinated program).

Oscar Johnston Cotton Foundation 35,000
(Annual allotments of $35,000 beginning July 1, 1952, except $40,000 for fiscal year 1954. Funds made available to the Center through the U. S. Department of Agriculture).

Facilities and Location: Since the issue of Pink Bollworm Information No. 1, a number of improvements and modifications have been made in buildings and other facilities.

The bioclimatic cabinet building has been lined, insulated, and made insect-proof. This will make possible the safe handling of the pink bollworm during noncotton season and of the Mexican fruit fly. A laboratory bench and cabinets have been installed along the wall of the building. A workroom and office space have been partitioned off, screened corridors have been provided and the general ventilating system changed. The instruments have been checked and some modifications in the controls made. It is proposed to include facilities for simulating precipitation in the cabinets when the experimental system has been satisfactorily developed and found to be reasonably accurate in performance. Ultraviolet and infrared lights and accurate temperature and humidity controls are already installed.

The half-acre cage has been painted and repaired. One room in the insect toxicology building has been insulated and an airconditioner installed, cabinets and sinks have been built in and devices for safely applying insecticidal sprays and dusts constructed. A store-room has been partitioned off in this building.

Forty 6 x 6 foot cages have been built and are being used for determining moth emergence from large samples of gin waste in the ginning experiments.

Some additional laboratory and office equipment has been secured.

The small office and laboratory and storage and garage buildings at Port Lavaca have been modified to accommodate the Texas Experiment Station workers who are headquartered there.

Cooperation: This occasion is taken to express appreciation of the full cooperation given by the several Federal and State agencies concerned with the pink bollworm problem, and also by industry. Without this, several of our lines of work would be difficult, if not impossible. The contribution of the Pink Bollworm Control Project is especially noteworthy. Some of the research personnel are paid by that project; moth emergence in some of the hibernation tests is recorded by Control personnel and some of those men actively participate in the gin and other studies. The hearty and substantial cooperation given in the gin work and in the light trap investigations by the U.S.D.A. Cotton Ginning Research Laboratories, Cotton Ginning Investigations, and the Farm Electrification Section are appreciated.

Meetings Attended by Research Personnel: The American Cotton Congress, sponsored by the Statewide Cotton Committee of Texas, which was held in Corpus Christi, Texas on June 3-4-5 was attended by F. C. Bishopp who

participated in a conference on ginning research with representatives of the ginners, State Department of Agriculture, Pink Bollworm Control Project, U.S.D.A. ginning engineers and Extension Service.

A number of members of the staff took part in a conference of Southern Agricultural Experiment Stations Directors and entomologists at which the pink bollworm situation and especially the research program was reviewed. This conference was held at the Research Center in Brownsville with a field trip to Port Lavaca, August 12-14, 1954. F. C. Bishopp took part in a meeting of the Pink Bollworm Research Advisory Committee held in conjunction with this conference.

The Eighth Annual Beltwide Cotton Mechanization Conference held in Little Rock, Arkansas July 28-29-30 was attended by F. C. Bishopp and C. N. Husman.

The International Pink Bollworm Advisory Committee met at the Center on August 18. Members of the staff participated in the discussions.

The Beltwide Pink Bollworm Committee met in the Adolphus Hotel, Dallas, Texas on September 23-24. The Research Center was represented by F. C. Bishopp and S. E. Jones. On invitation, Dr. Bishopp presented a review of research underway and research needs.

F. C. Bishopp attended the meeting in El Paso, Texas and Mesilla Park, New Mexico of the Cotton and Cottonseed Advisory Committee and discussed the pink bollworm research work.

Personnel: Dr. Sloan E. Jones was appointed Station Leader by the U. S. Department of Agriculture on September 1, 1954. Dr. Jones was formerly Vice Director of the Texas Agricultural Experiment Station, and has had wide experience in farm management and related fields. He majored in entomology and did entomological work for several years before becoming Vice Director of the Texas Experiment Station.

Ching Hsi Tsao, Ph.D. (University of Minnesota) reported for duty at the Center on July 12, 1954. He has been assigned to work on insect toxicology, a field in which he was trained and in which he worked for two years at the Beltsville Laboratory of the Entomology Research Branch, U. S. Department of Agriculture.

Mr. Norman Flitters of the Honolulu staff of the Fruit Insects Section, Entomology Research Branch, is spending several months at the Center readying the bioclimatic cabinets for studies on the Mexican fruit fly and pink bollworm.

No other changes except in temporary assistants have been made.

Visitors: Numerous individuals representing various industries connected with cotton have visited the Center.

Mr. Juan Simon Fernandez of the Ministry of Agriculture in Peru spent several weeks at the Center during June and July studying this research problem. Mr. Juan Herrera, also of Peru and who was studying at Texas A. & M. College under a Rockefeller scholarship, spent the week of June 28 at this laboratory. Mrs. Melika Karmen and Mr. Ihsan Ural of Turkey, participating in a training course in Plant Quarantine and Plant Protection, visited this Center July 23-26.

The following Experiment Station Directors and entomologists attended the pink bollworm conference at the Center August 12-14: Alabama, Dr. E. V. Smith, Director, and Dr. F. S. Arant, Head, Entomology Department; Arkansas, Dr. John White, Associate Director, and Dr. Charles Lincoln, Head, Entomology Department; Louisiana, Dr. I. L. Forbes, Assistant Director, and Dr. L. D. Newsom, Entomologist; Mississippi, Dr. D. Gray Miley, Member of the Pink Bollworm Advisory Committee and representing the State Experiment Station; New Mexico, Dr. J. R. Eyer, Head, Entomology Department; North

Carolina, Mr. George D. Jones, In Charge, Extension Entomology; Oklahoma, Dr. Louis E. Hawkins, Director, Dr. D. E. Howell, Head, Entomology Department, and Dr. D. E. Bryan, Entomologist; South Carolina, Mr. L. M. Sparks, Entomologist; National Cotton Council, Mr. Claude L. Welch, Director, Production and Marketing Division, and Dr. H. G. Johnston, Head, Research Development; U. S. Department of Agriculture Representatives, Mr. K. P. Ewing, Head, Cotton Insects Section, Mr. W. G. Bruce, Head, Methods Improvement Section, Mr. L. F. Curl, Head, Cooperation with North American Countries, Mr. R. W. White, Project Leader, Pink Bollworm Control Project, and Mr. D. M. McEachern, Area Leader, Pink Bollworm Control.

STATUS OF PINK BOLLWORM CONTROL AS OF SEPTEMBER 17, 1954 (R. W. White)

Activities of the Pink Bollworm Project are now or will within a short time be at their peak, and information developed as a result of the next month or six weeks' work will be of great interest. By that time a rather accurate picture of the status of the infestation in all the regulated areas will have been determined and any further spread of the pest to new areas detected.

In the spring and early summer a limited amount of bloom inspection was done in certain parts of the regulated area where personnel was available and where it seemed worth while to determine the degree of carryover. The results of this bloom inspection indicated a lower early population in the Rio Grande Valley and Coastal Bend counties. In a few counties in the Winter Garden area of Texas the indicated carryover was greater than last year. The most important information developed by bloom inspection was in regard to the increase in degree of infestation in central Texas, partiularly in those counties between Austin and Waco. The infestation was not

uniformly heavy, and in nearly every case the districts showing the most increase were those in which late crops were produced the preceding year.

In central Texas bloom infestation was found as far north as Bosque County, and in northwest Texas the most northerly points were in Lubbock and Yoakum Counties. Light bloom infestations were recorded in the Pecos and El Paso Valleys, and about 40 percent of the fields examined in the Juarez Valley were infested. One pink bollworm was found in bloom inspection in De Baca County, New Mexico, the most northern point of bloom infestation observed.

Enough gin trash inspection in South Texas was done to obtain some information on the status of the pink bollworm as the crop developed. Infestation in the Lower Rio Grande Valley counties was about the same as last year, although the inspection work was done somewhat later. Heavier infestations were found in the border counties from Starr up to and including Maverick. The central Texas area, as forecast by bloom inspection, showed a considerable increase from 6.69 pink bollworms per bushel to 20.44 in a group of 13 counties.

A meeting was called at Waco under the auspices of the Insect and Disease Control Section of the Statewide Cotton Committee of Texas on August 23 and was attended by representatives of the State and Federal Departments of Agriculture, Extension Service, oil millers, farmers, radio, and press. The pink bollworm situation was fully explained by a number of speakers and a set of recommendations aimed at taking advantage of the unique opportunity resulting from the extended drouth to secure an early cleanup of cotton fields was presented and adopted.

A few pink bollworms have been found in southwestern Louisiana and three in De Soto Parish of that State. Other gin trash crews are working

in Georgia, Florida, western Mississippi, southwestern Arkansas, and in central Texas. So far no record of new infestations has been received.

Traffic leaving the Lower Rio Grande Valley was checked at Falfurrias and Riviera during the rush periods during part of July and the entire month of August. The purpose was to intercept as much infested material as possible that might be carried by migratory cotton pickers. During the latter part of August and early in September spot checks were made at or near crossings of the Brazos River in Texas for the same purpose.

The Louisiana-Arkansas traffic inspection work, in which the Project cooperates, was set up early in August. Eight of the stations are located at points on the Louisiana-Texas border and three near the Arkansas-Texas border. Large numbers of migratory cotton pickers pass through these stations, and interceptions of material containing live pink bollworms have been rather frequent lately, particularly at the Arkansas stations. All cotton picking sacks are fumigated before being released.

The Project has assisted in setting up the stations which the State of Mississippi has established at Vicksburg, Natchez, and Greenville.

In the cultural control zones in Texas the earliest stalk destruction date is August 31 in the Lower Rio Grande Valley. An identical date is required in the Matamoros section of Mexico. On the American side observance of the deadline date was excellent in general, although a few charges were filed for noncompliance. Some delay was experienced on about 10 percent of the acreage on the Mexican side due to some late cotton and showers that interfered with completion of this work.

In the zone in which stalk destruction is required by September 25 excellent compliance was obtained.

THE TEXAS AGRICULTURAL EXPERIMENT STATION (J. C. Gaines)

1. Development of Stalk Cutter-Shredders: This experiment was located at Santa Maria, Texas and was a split-plat design using ten replications to test two machines. Each whole plat was two rows wide and 352 feet long. Each subplat was two rows wide and 176 feet long. The subplat treatments were: (1) before and (2) after shredding. The sample of each subplat consisted of all the boll material on 1/25th acre. These samples were placed in cages at the Brownsville laboratory and the number of emerging pink bollworm moths will be recorded. (See Page 34)

Another experiment will be conducted at Port Lavaca and the samples will be caged in that area for observation. An experimental machine will be compared with a modified commercial machine in replicated plats. No further testing of commercial machines is contemplated.

M. G. Davenport, Agric. Engineer
W. J. Magee and G. P. Wene, Entomologists, (Port Lavaca & Weslaco).

2. Development of Sprayers and Dusters: This experiment was located near Port Lavaca on a field planted May 20 and was of randomized block design in which 9 treatments were replicated 4 times. Each plat was 0.1 acre in size. The treatments and yields were as follows:

Treatment	Yield Seed Cotton Per Acre
A - Check	492
B - Dust - 1 nozzle per row	540
C - Dust - 2 nozzles per row	532
D - Spray - 3 #2 nozzles per row - 6 gallons per acre	482
E - Spray - 3 #3 nozzles per row - 9 gallons per acre	490
F - Spray - 3 #6 nozzles per row - 18 gallons per acre	494
G - Spray - 5 #2 nozzles per row - 10 gallons per acre	490
H - Spray - 5 #3 nozzles per row - 15 gallons per acre	485
I - Spray - 5 #6 nozzles per row - 30 gallons per acre	548

A mixture of dieldrin-DDT was used in all treatments; the dust being a 2½-20% mixture applied at 15 pounds per acre and the sprays being a

1-2#/gallon emulsifiable concentrate with sufficient DDT (2#/gallon) added to apply the spray at the rate of 1/2# dieldrin-3# DDT per acre. Three effective applications of insecticide were made on August 10, August 17 and August 24. The average infestation on the indicated dates are given in the following tabular form:

	Infestation on date indicated					
	8/9		8/16		8/23	
Treatment	% Injury	# Worms	% Injury	# Worms	% Injury	# Worms
A-Check	35.8	88.8	79.5	307.2	79.2	306.5
B-Dust 1 nozzle	64.2	191.8	61.2	160.5	53.0	195.2
C-Dust 2 nozzles	28.8	65.0	63.2	198.2	64.0	149.8
D-Spray 6 gal/acre	34.5	89.5	44.8	102.0	59.2	172.8
E-Spray 9 gal/acre	46.0	139.8	70.2	208.2	52.0	142.0
F-Spray 18 gal/acre	57.8	172.2	49.2	129.2	52.2	177.2
G-Spray 10 gal/acre	44.2	154.0	62.5	143.8	59.5	186.5
H-Spray 15 gal/acre	45.5	130.2	55.5	156.8	60.8	197.0
I-Spray 30 gal/acre	72.5	190.0	51.5	157.0	54.8	136.5

The cotton on the experimental plats was picked on August 27 and September 10. Yields were taken on 1/25 acre plots within each treated plat. Adequate buffer areas separated each picking area to minimize the effects of drift. Samples were also taken for classing.

W. A. Magee, Entomologist
M. G. Davenport, Agric. Engineer

Spray-dust experiment at Weslaco.- A pink bollworm control experiment was also conducted in the Valley on Frank Schuster's farm using 2 dust nozzle arrangements and 6 spray nozzle arrangements. These treatments were to start when 10 percent of the bolls were infested. Each plot was 0.1 of an acre in size, with each treatment being replicated 4 times.

Treatments for boll weevil control were carried out on June 2, 7, 12, and 23. On June 24 the top crop was destroyed by a hurricane. The entire field was hand dusted with 2.5 percent dieldrin, while it was still wet. Dieldrin was applied as a spray on July 10, 15, 21. Small showers fell

almost daily during that period. On July 26 the pink bollworm infestation was approximately 7 percent so the pink bollworm treatments were begun. Practically all the cotton opened by August 1.

Because of the rainy weather boll weevil control was not as good as would be expected under normal weather conditions. The seasonal boll weevil infestation was 35 percent punctured squares in the untreated plots and 31 percent in the dieldrin treated plots. The dieldrin dusted yielded only 231 pounds more seed cotton than the untreated plats. The dieldrin sprayed plats (one of the 10 applications was dust applied by hand dusters), having the same amount of dieldrin applied, yielded 516 pounds more seed cotton per acre. The data indicate that during rainy weather sprays are more effective than dusts.

Results of this test indicated that the pink bollworm did not build up in cotton which matured by August 1.

G. P. Wene, Entomologist (Weslaco).

3. Resistance Studies: In the seasonal history study 49 moths emerged from hibernation cages during August. This makes a total of 1970 moths recovered from an estimated 3000 long cycle larvae caged last fall.

Moth releases in the field cage variety screening tests were made during August. Two collections of bolls were made and examined for larvae. All varieties are not fruiting at present but, by making periodic releases in the cages, the data from later fruiting varieties should be comparable. None appear resistant to date.

Field planted G. thurberi has just started to fruit and extensive tests will be conducted on this species in the next few months.

Observations on the behavior of the larval stage during the process of screening cotton for resistance indicated that the pink bollworm may

be somewhat cannibalistic. It was noted that when two or more larvae entered a loculus near each other seldom would more than one larva be found inside. Further observations indicated that this probably is not truly cannibalism but that the larvae are antagonistic and when they encounter each other they fight and frequently one is killed or injured. As soon as one is injured and ceases to fight, the other pays no further attention to it. Tests are being conducted to substantiate these observations.

Migratory habits of the larvae are also being investigated. Preliminary observations indicate that the freshly hatched larvae avoid each other and migrate over the plant quite freely.

J. R. Brazzell, Grad. Asst. Ent.
(College Station)

4. Evaluation of Growth Inhibitors: Experiment 1.- An experiment testing five materials was in progress near Long Mott, Texas. The initial infestation was approximately 40%. Results from this test will be reported later.

Experiment 2.- Season following application with and without early plow-under. This experiment is progressing on schedule. Spraying with five materials has been done and stalk destruction completed. Results will be available when moths have emerged next growing season.

S. P. Johnson, Plant Physiologist
(College Station)
W. J. Magee, Entomologist
(Port Lavaca)

Screening tests conducted at College Station during August and September included 16 experimental materials applied to approximately 64 different plats. The results of this test will be completed in October.

S. P. Johnson, Plant Physiologist
(College Station)

5. Evaluation of Treatment Combinations for Pink Bollworm Control:

This experiment was a split-plat-factorial design in which the main effects (planting date) were partially confounded with replications and the sub-effects were arranged in random series within each whole plat. Each whole plat (planting date) contained all possible combinations of insecticide, defoliant and stalk shredder, i.e., 8 subplats, in each of 3 replications. Each subplat was 0.1 acre in size and replications were separated by 40 foot alleys. The treatments (sub-effects) were as follows:

A - Check
B - Insecticide (dieldrin-DDT)
C - Defoliant (aerocyanamide + amino triazole)
D - Stalk cutter-shredder
E - Insecticide + defoliant
F - Insecticide + stalk cutter-shredder
G - Defoliant + stalk cutter-shredder
H - Insecticide + defoliant + stalk cutter-shredder

The early planting was made on March 9 and the late planting was made on April 22.

Dieldrin was used in this experiment for boll weevil control and DDT was used for pink bollworm control. Application was begun when the average infestation reached sufficient numbers to warrant insecticide applications according to directions given in the 1954 "Guide for Controlling Cotton Insects in Texas". The dosage used was also that recommended by the Guide. Applications were made at weekly intervals with a nozzle arrangement of 3 #2 nozzles per row (6 gallons per acre). The defoliant was applied with 6 nozzles per row (4 #6 nozzles and 2 #3 nozzles) at the rate of 30 gallons per acre. The dosage was 8 pounds aerocyanamide and 0.5 pounds amino triazole per acre. In addition to the above chemicals all plats received an early application of demeton (1/8 pound per acre) for aphid control on May 28.

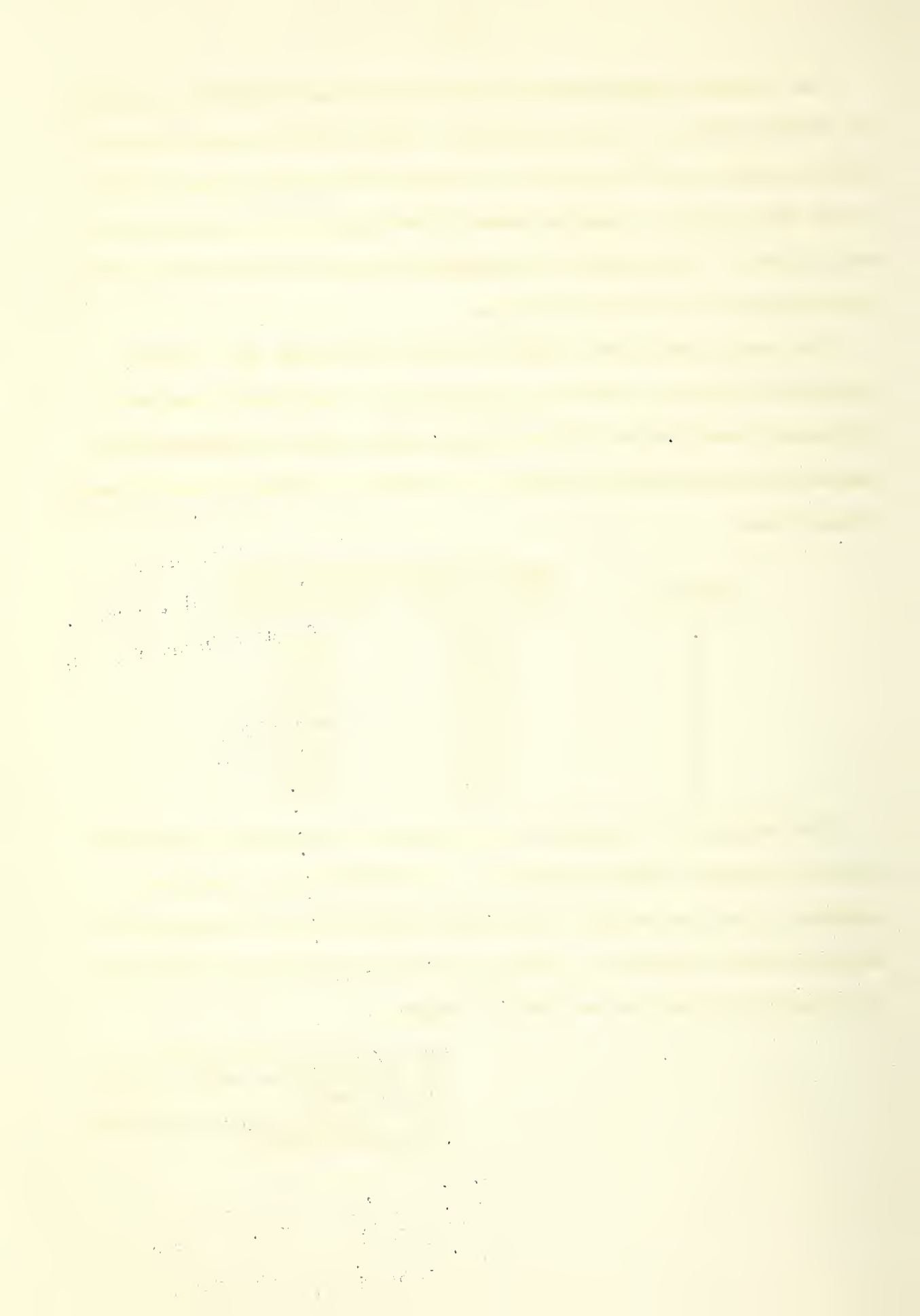
Two effective applications of dieldrin were made on July 7 and July 16 for weevil control in the late planting. Three effective applications of DDT were made on July 22, July 28, and August 3 for pink bollworm control in the late planting. Damaging insect infestation did not develop in the early planting. The defoliant was applied on July 27 in the early planting and on August 7 in the late planting.

The early planting was picked on July 28 and August 30. The late planting was picked on August 12 and August 30. The picking areas were 1/25 acre in each subplat with sufficient buffer areas to minimize drift. Samples were also taken for grading. The yields are given in the following tabular form:

Treatment	Yield in Seed Cotton Per Acre	
	Early Planting	Late Planting
A	935.0	682.5
B	967.5	760.0
C	915.0	717.5
D	902.5	717.5
E	972.5	700.0
F	950.0	682.5
G	865.0	717.5
H	947.5	700.0

The residual boll material from 1/25 acre of non-shredded plats was placed in emergence cages September 11. The shredded plats were cut September 13 and the residual boll material from 1/25 acre was placed in emergence cages September 15. Emergence of moths from this material will be checked throughout the next growing season.

W. J. Magee, Entomologist
M. G. Davenport, Agric. Engineer
(Port Lavaca)
S. P. Johnson, Plant Physiologist
(College Station).



PINK BOLLWORM RESEARCH CENTER AND SUBLABORATORIES

Insecticides (C. A. Richmond, R. L. McGarr, W. L. Lowry, J. A. Griffin, and C. H. Tsao): Pink bollworm insecticide experiments were conducted at Brownsville, Port Lavaca, and Presidio, Texas and at Torreon, Coah., Mexico. In the first two localities, insecticides were used for control of both the pink bollworm and boll weevil, and also some data were obtained on the control of other cotton pests. Equipment was installed at Brownsville for laboratory screening of chemicals against the pink bollworm. Twenty-six compounds were given a preliminary evaluation as contact and residual insecticides against adults and larvae. Results are given below.

Experiments on Control of Pink Bollworm and Boll Weevil at Brownsville: Insecticide experiments on plots in the Lower Rio Grande Valley were handicapped due to lack of sufficiently high infestation. A great deal of time was spent making a survey of many fields in search of suitable infestations. Some fields were tentatively selected, checked periodically for several weeks, and then abandoned due to failure of the infestation to build up as anticipated. Because of these adverse conditions some of the experiments originally planned could not be conducted.

Four series of small-plot tests were conducted for control of the pink bollworm and the boll weevil. The poison applications were made with rotary hand dust guns or knapsack sprayers, and most of the applications were made early in the morning at 4-or 5-day intervals until the infestations were brought under control.

Infestation records were made for the pink bollworm and boll weevil at about weekly intervals insofar as possible. Usually 200 squares per plot were examined for the boll weevil for each infestation count and 50 bolls for the pink bollworm. Population records were also obtained for

the bollworm, aphid, and cotton fleahopper when there was evidence of any appreciable injury.

Series 1, tests 1 and 4.- This series consisted of test 1 with four replicates and test 4 with 3 replicates, making a total of 7 replicates of each treatment and the check. The plots were randomized and 1/3 acre in size. The treatments, average yields, and gains over the check were as follows:

Treatment	Pounds of seed cotton per acre	
	Yield	Gain
Check	2366	--
Low-lime calcium arsenate + 1% methyl parathion	2484	118
1½% endrin and inert	2594	228
2% dieldrin + 1% methyl parathion + 5% DDT and inert	2631	265
2½% dieldrin and sulfur	2537	171

All of the treatments gave satisfactory control of the boll weevil, and there was little difference between the results obtained for the different treatments. The populations of the pink bollworm were not high enough for any definite conclusions to be drawn on the effectiveness of the different treatments used.

Series 2, test 3.- This series consisted of 4 replicates of each treatment on randomized plots 1/3 acre in size. The treatments, average, yields in pounds of seed cotton per acre and gains were as follows:

Treatment	Pounds of seed cotton per acre	
	Yield	Gain
Check	2159	--
3% high gamma BHC + 5% DDT and sulfur	2562	403
3% low gamma BHC + 5% DDT and sulfur	2383	224
5% gamma BHC + 5% DDT and sulfur	2558	399
Low-lime calcium arsenate + 1% parathion and 20% DDT, in alternate applications	2515	356
Low-lime calcium arsenate	2415	256

All treatments gave satisfactory control of the light boll weevil infestation prevailing in this test.

All of the mixtures with DDT gave noticeable reductions of the pink bollworm populations, with but little difference between the different mixtures.

Aphids did not increase enough to be of importance until near the end of the season. All of the BHC treatments and the treatment of low-lime calcium arsenate plus 1% parathion with 20% DDT added in alternate applications gave satisfactory control of the aphids. The greatest increase of aphids occurred where the low-lime calcium arsenate alone was used.

Three square infestation records were made for the bollworm, with there being less than 3 percent difference between any of the treatments and the check.

Series 4, test 5.- This series consisted of 4 replicates on 1/4-acre plots. The following dusts used and the yields in pounds of seed cotton per acre and the gains were as follows:

Treatment	Pounds of seed cotton per acre	
	Yield	Gain
Untreated check	2744	--
1.5% dieldrin + 5% DDT + 40% sulfur	2800	56
1.5% dieldrin + 10% DDT + 40% sulfur	2904	160
2.5% dieldrin + 10% DDT + 40% sulfur	2880	136
3% GBHC + 5% DDT + 40% sulfur	2848	104
20% toxaphene + 10% DDT + 40% sulfur	2968	224

This test was conducted on late planted cotton and it was expected there would be a heavy insect migration into the fields when surrounding early plantings matured. Treatments were started at a low level of infestation when the first bolls were about 20 days old. Heavy rain on June 25 was accompanied by winds up to 60 miles per hour which stripped most of the squares from the plants. The anticipated heavy build-up in pink bollworm and boll weevil infestation did not develop.

Cotton Plant Response to Systemic Chemicals: Two small plot tests were conducted to determine the effect of four of the more promising systemic chemicals applied as foliage sprays on the growth and appearance of seedling cotton. No beneficial or harmful effects were observed. It should be kept in mind that these were foliage treatments and not seed or soil treatments.

Fumigation Tests on Pink Bollworm Eggs: Okra is permitted to move from the Lower Valley after having been fumigated with methyl bromide. Since information was lacking as to whether the fumigation would kill pink bollworm eggs, tests were conducted in a standard fumigation chamber in cooperation with Messrs. R. B. Lattimore and A. L. Williamson. The dosage of methyl bromide was that recommended for treating okra, i.e. 1 to 1¼ pounds per 1,000 cubic feet. Some of the 6,700 eggs treated showed considerable embryonic development after fumigation but no hatching occurred.

Tests with Pyrethrum and Pyrenone Against Pink Bollworms in Stored Seed: Preliminary tests were conducted with pyrethrum and pyrenone for control of overwintering pink bollworms in stored cottonseed and seed cotton. A commercial dust formulation was used which was labeled as follows: Pyrenone, .80%; pyrethrins, .05; inert, 99.15. One-pound samples of seed and seed cotton were treated at various rates from 12.5 to 200 grains per pound and caged for moth emergence. About 50 percent kill resulted at the 100 grain dosage (58 pounds per ton).

Laboratory Toxicological Studies: Considerable time has been devoted to working out methods and techniques for studying the initial and residual toxicity of chemicals to pink bollworm in different stages of development. Some attention was given to the working out of appropriate methods for testing chemicals as attractants or repellents.

The effect of different solvents on pink bollworm were tested and it was found that dilute solutions of insecticides in xylene could be used to measure toxicity in contact and residual studies in most laboratory tests; most of the tests conducted during the quarter consisted of direct applications and exposing moths and larvae to the insecticidal residues remaining when glass surfaces were sprayed with known quantities of chemicals dissolved in xylene.

Fifteen of the 26 chemicals used in studies of their initial and residual toxicity to pink bollworm showed high initial toxicity to moths. Eight of these 15 chemicals were also effective in killing larvae. The toxicity of some of the chemicals that showed high initial kill was soon lost, but a few continued to show high moth and larval mortality for several days. A number of tests of materials designed to increase the duration of effectiveness of insecticides have been conducted without conclusive results.

Insecticide Work in Mexico: In the Laguna District of Mexico extensive cooperative tests of the use of insecticides for control of the pink bollworm and other cotton pests were carried out. The general use of DDT or of insecticidal preparations containing DDT apparently has considerably reduced the pink bollworm population over the entire cotton growing area. Tests of early season application of insecticides also appear to show better pink bollworm control than similar late season applications.

Biological Control (J. M. McGough): Several shipments of parasites and predators have been received in the Moorestown, New Jersey laboratory from Mr. G. W. Angelet who is still working in India. Some of these have been multiplied at Moorestown and these, together with smaller lots as received from India, have been forwarded to the Center. Six of the most promising species totalling over 377,000 specimens have been released in 15 counties

in southern Texas and in Tamaulipas, Mexico during 1954. These releases were made in 422 colonies in cotton fields and in adjacent areas where the parasites might find alternate hosts upon which to develop. The total number of parasites and predators released during 1953-54 was approximately 730,000 specimens in 809 colonies. Recently about 20,000 specimens of parasites were shipped to Mexico City for distribution by Mexican officials in the Laguna District.

Collections were made of 500 to 1,000 pink bollworm infested bolls from several fields after parasites had been liberated. These were caged and observed for parasite emergence, but no parasites were recovered. All of these fields had been treated with insecticides and full information was recorded on the kinds of materials used and number of applications.

Although no recoveries of these parasites have been made thus far, it should be borne in mind that occasionally introduced species of parasites do not become apparent in the field for several years after release. At most, it is felt that beneficial insects will not prove to be more than a supplement to cultural and other control practices.

An insect pathologist to study diseases of the pink bollworm and other cotton insects has not yet been assigned to work at the Center.

Cotton Varietal Susceptibility to Pink Bollworm Damage (Ivan Shiller and Cotton Breeders): Seed of a considerable number of hybrids of various specimens of Gossypium was planted in a large screen cage and the plants are now fruiting freely. This cage was heavily infested with pink bollworm moths and all of the hybrids are showing infestation. Comparisons have not been made of the extent of infestation to date.

Hibernation (A. J. Chapman, L. W. Noble, Ivan Shiller, G. L. Smith, O. T. Robertson, and C. R. Parencia): Pink bollworm hibernation experiments were conducted at Brownsville, Port Lavaca, Waco, Greenville, Mount Pleasant, Lubbock, and Vernon, Texas and at Chickasha, Oklahoma. Similar experiments were conducted in the previous year at the same localities except Mount Pleasant which was added to the list this year. Climatic conditions at the various locations ranged from subtropical and humid at Brownsville to cold and arid at Lubbock.

Eighty hibernation cages, each containing 3½ pounds of infested open bolls, were installed at each locality. These cages were divided into 4 groups of 20. In 3 groups the bolls were placed on the soil surface and buried either in the fall or spring or were not buried. In the fourth group the bolls were placed above the ground to simulate conditions on standing stalks and were buried in the spring.

In all burial treatments the bolls were placed about 2 inches below the surface. An estimate of the number of larvae at each locality was obtained by examining a sample of bolls at the time they were placed in the cages. The cages were equipped with moth traps in the spring and daily records made on moth emergence for computing the percentage survival.

Owing to the wide variation in seasonal conditions in the different localities, the experiments were begun on different dates. The bolls were placed in the cages on September 1 at Brownsville, October 10 at Port Lavaca, and November 15 at the other localities. Those in the fall burial series were buried at the time they were placed in the cages. The spring burial dates were January 15 at Brownsville, February 1 at Port Lavaca, and March 1 at the other places. Screen pyramids equipped with moth traps were placed on the cages March 1 at Brownsville and Port Lavaca and April 1 at all other places.

Weather conditions permit considerable moth emergence in the fall at Brownsville and Port Lavaca, and there is some activity throughout the winter. This emergence occurring before installation of the traps and when cotton was not available for propagation of the insect, could not be taken into account in the survival figures for these two localities whereas the total moth emergence was used in calculating the percentage survival at the other places.

Records show that the peak in moth emergence at Brownsville occurred in the week ending May 1; Port Lavaca, May 22; Waco, June 12; Greenville, May 29; Mount Pleasant, June 5; Lubbock, June 19; Vernon, June 12, Chickasha, June 12.

The pink bollworm survival for each treatment and the average for all treatments at each locality are recorded in the accompanying table including a comparison with the previous year's records. Survival at the different localities varied widely and there was considerable difference between the two years. Moth emergence in the fall and winter reduced the carryover at Brownsville and Port Lavaca. Soil temperatures at Brownsville were sufficiently high to cause a great mortality in the first weeks of the 1952-53 experiment whereas rainfall the last of August in 1953 reduced soil temperatures and caused an increase in survival for the 1953-54 experiments. The experiment at Lubbock also showed a marked increase in survival in 1953-54 over 1952-53 despite the latter being a colder winter. This increase is believed to be due to lack of spring rainfall to stimulate emergence in the spring of 1953. Survival at Port Lavaca and Vernon was about the same for the two years and at Waco, Greenville, and Chickasha considerably lower in 1954. No satisfactory explanation has yet been given for the low survival at Greenville compared to that at Waco and Mount Pleasant, but it was

probably due in part at least to the cool wet November, December, and January and the heavy black soil which was not very well drained.

Of the 4 treatments, fall burial of infested bolls caused the lowest survival at localities with mild temperatures and heavy rainfall--that is, at Brownsville, Port Lavaca, Waco, Greenville, and Mount Pleasant. In the localities with colder winter temperature—that is, at Lubbock, Vernon, and Chickasha, survival was lowest in bolls above ground simulating conditions on standing stalks. At all localities fall burial decreased survival below that for bolls that remained on the soil surface until buried in the spring. At all places except Brownsville survival was highest on bolls that remained on the soil surface throughout the experiment.

Pink bollworms surviving hibernation under various conditions in Texas and Oklahoma during the winters of 1952-53 and 1953-54.

Locality	Number of larvae in each treatment	Percent survival in bolls: On soil surface: Buried in fall	On soil surface: Buried in spring	On soil surface: Not buried	On stalks: buried in spring	Average
		Tests for winter of 1953-54				
Brownsville	6,580	1.23	1.97	4.42	5.07	3.18*
Port Lavaca	8,448	.07	.65	2.93	2.39	1.51
Waco	8,740	1.61	2.46	17.16	2.91	6.03
Greenville	8,740	.06	.02	.07	0	.04
Mt. Pleasant	8,740	.20	1.54	21.04	.53	5.83
Lubbock	5,220	1.28	1.09	9.64	0	3.00
Vernon	4,260	.98	1.24	10.16	0	3.10
Chickasha	4,500	.33	1.00	6.64	.02	2.00
		Tests for winter of 1952-53				
Brownsville	10,800	0	.04	.01	.15	.05
Port Lavaca	6,870	.01	.42	2.54	1.31	1.07
Waco	5,676	1.09	22.15	25.16	16.91	16.33
Greenville	8,544	.71	4.18	16.20	2.25	5.83
Mt. Pleasant	--	--	--	—	--	--
Lubbock	3,998	.13	.23	2.35	.03	.68
Vernon	4,552	.48	2.44	8.13	.20	2.81
Chickasha	4,184	.72	9.70	15.97	.05	6.61

* Rain the last of August decreased high soil temperature in September, thus pink bollworm survival increased over that of the previous year.

Survival in Free Cocoons at Port Lavaca: In western Texas and other areas with similar climates, pink bollworms making their exit from green bolls late in the growing season enter a resting stage and live overwinter. Although the mortality of these larvae is much higher than that for larvae in seed, they are a factor in winter carryover. In the lower Rio Grande Valley such larvae pupate and emerge during the fall or early winter months and have never been found to live overwinter. A small series of cages containing larvae that cut out of green bolls was installed at Port Lavaca last fall to determine whether the larvae would live through the winter in that area.

Trays with hardware cloth bottoms were placed on the hibernation cages and infested green bolls were placed in the trays so that the larvae could drop to the ground and spin cocoons in the cages. Equal lots of bolls were placed over each of 5 cages and another lot was used for making daily counts of the larvae in order to obtain an estimate of the number per cage. The larvae dropped into the cages and spun cocoons during the period from October 8-24. There were 230 larvae per cage or a total of 1150 for the series. Only 1 moth emerged the following spring from these 1150 larvae.

Seasonal Abundance and Distribution of the Pink Bollworm (R. L. McGarr, C. A. Richmond, O. L. Walton, O. T. Robertson, and Staff of Pink Bollworm Control Project): Gin trash inspection by the Pink Bollworm Control Project showed a decrease in infestation in southern Texas counties as a whole, but the Winter Garden section and some counties of south central areas showed increases.

Early season bloom inspection in the lower Valley showed a much lower carry-over this year than last year. Extensive scouting in search of fields for use in insecticide experiments failed to disclose any with sufficient infestation to adequately evaluate insecticides. Near the end of the season

the few remaining green bolls in the top of the plants were heavily infested in many fields, but the small amount of the crop involved in such conditions was of little consequence. A few late plantings sustained a considerable loss due to infestation by this insect.

Alternate Host Plants of the Pink Bollworm (Ivan Shiller, G. L. Smith, and Jack Sherrer): A cage covering more than 1/2 acre is being utilized at Brownsville to grow approximately 40 species of malvaceous plants where they are exposed, together with cotton, to a high pink bollworm population. Seed pods are examined or caged for possible moth emergence to determine the plants on which the insect may propagate. The different Malvaceae were collected in Texas, Oklahoma, Louisiana, and Florida through cooperation with State and Federal agencies. Three cages covering an area 3 x 6 feet each were placed over flax and pink bollworm moths introduced to determine if the insect would develop on this plant. Seed pods of several wild mallows were collected in the Port Lavaca area and caged for possible pink bollworm moth emergence.

The findings to date of pink bollworms developing on plants not previously known to become infested are shown below:

Hibiscus tubiflorus (large cage with cotton)
Kosteletzskya althaeifolia (large cage with cotton)
Linum usitatissimum, Flax (small cage without cotton)
Sida cordifolia (field collection at Port Lavaca)

Physiology, Morphology, Histology, and Biochemistry Investigations (E. W. Clark and Dan Chadbourne): In a biochemical study to determine the relationship between body fats and diapause, pupae and fourth instar larvae from squares and green bolls were analyzed for total moisture, fat, and iodine values. Analyses of sexes were significantly different only between live and dry weights of male and female pupae. Larvae from bolls were

significantly higher than larvae from squares in live and dry weight, percent moisture, percent fat on wet and dry basis, milligrams fat per larva but not iodine values.

Qualitative analyses of the free amino acids in the haemolymph of the non-resting fourth instar larvae have been carried out using ascending paper chromatographic technique. The analyses show 23 amino acids, and 2 peptides to be present.

Intensive studies on rearing techniques and nutrition are now underway to develop a laboratory culture of pink bollworm. It is imperative that such a culture be developed. With cottonseed as a base, some fifteen media have been screened and several have produced larvae of normal size and color in the usual time. Pupae and resulting adults have also been normal. These media contained various cottonseed products, yeast, agar, and other ingredients. Cottonseed meal, although containing a high level of B vitamins, required the addition of yeast to give good larval growth. High water content was also an important element. The first instar larvae should have a medium with about 70 percent water to produce optimum growth. Peanut flower has recently been found to serve well as a base material. The fruit and flowers of two alternate host plants of the pink bollworm and soybean flower have been tried with little success. None of these media and rearing techniques, however, are adequate for mass rearing. The research has been greatly hampered by extremely high contamination of molds which are very prevalent in this area. However, progress is being made in controlling them by a combination of fungistatic agents and sterile techniques and it is hoped this problem will be reduced to a minor one.

Methods of Destroying Pink Bollworms in Cottonseed, Seed Cotton, and Gin Waste (D. H. Currie, O. T. Robertson, O. L. Walton, and others): In order to evaluate the effect of different gin equipment on pink bollworm in the cotton passing through the gins and the effect of different mechanical processes on worms in gin trash, samples of the various types of material were hand examined, and in a number of cases other samples were placed in cages and the emergence of moths recorded. It was recognized that larvae found by cutting seed in the hand examinations might still be alive shortly after passing through the gin, but might be injured so that they would not produce moths.

Cottonseed accumulated from several of the ginning experiments with the 1953 crop which were briefly reported upon in the last Information Circular were placed in cages at Lubbock the latter part of May 1954. The estimated number of pink bollworms in this seed before the cotton was ginned was approximately 56,000. The number determined as being present after the ginning process was 477 and only 4 moths emerged from this caged material.

Tests of the mechanical treatment of gin trash for the purpose of killing the pink bollworm, thus permitting the trash to be returned to farms for feeding and soil conditioning were carried out in cooperation with the U. S. Cotton Ginning Branch Laboratory at Mesilla Park, New Mexico. Samples of the material before and after being put through the several types of fans were taken and caged for moth emergence at Lubbock, Texas. Although 712 moths emerged from the check samples, not a single moth came out of the samples after having been passed through the fans. Since Texas ginners, particularly those in the Plains area, have been pressing for a more convenient and less expensive process of treating the gin trash for

pink bollworm destruction, rather extensive tests of various types of equipment have been initiated.

Thirty-seven tests were made at 13 gins in the Lower Rio Grande Valley, 5 in the Winter Garden area, and 2 at Port Lavaca. Field infestation counts were made to locate heavily infested material to put through these tests. In each of these tests the trash from 1 to 4 bales of cotton was collected and all classes of waste discharged from the different cleaning machines was passed through single conventional fans of various sizes (Nos. 20, 25, 30, 35, and 40) and speeds. Three 1-pound samples of trash were examined by hand. A 50-pound lot was caged for moth emergence and the remainder run through a gin trash machine for inspection for free larvae.

No larvae were found in the trash by hand examination and only 2 were found in each of 2 tests with No. 30 fans. Thus far, only 2 moths have emerged from the caged trash passed through No. 30 fans and none from larger fans.

From 21 of the above mentioned gin tests 1-pound samples of the seed were taken and examined for pink bollworms. Live worms were found in only 6 of these samples. The percentage of survival among these ranged from .068 to 21.35.

Four tests were conducted with a steel roller device designed to crush pink bollworms in the trash. Pink bollworm infested material was put through these rollers and from one test involving 60 pounds of trash, 5 pink bollworms emerged.

Additional tests were carried out with an Entoleter with 12 and 14 inch rotors operated at 1750 RPM. Cottonseed containing 265 larvae were

put through a 14-inch rotor. From these seed, 4 moths emerged (1½%). No moths were produced from 3 lots of seed containing 795 larvae which were put through the 14 or the 10.75-inch rotor 2 or 3 times.

Experiments were conducted in which infested cotton was put through newly developed individual pieces of cleaning equipment such as the Continental type impact cleaner. Although a high percentage of kill was effected, some moths emerged from nearly all of the material caged after treatment. Of course, complete kill should hardly be expected from a single piece of gin equipment.

Pink bollworm infested cottonseed was put through the standard oil mill process at Lubbock. Twenty-six percent of the larvae survived the first delinting process and 1.8 percent survived the first and second delinting. Large numbers of live larvae were found in the shaker waste. Some living larvae were found in motes that had not passed through the mote beater, but none after passing through that equipment. No live worms were found in linters, lint beater waste, or in seed hulls or meats.

Lots of from 2 to 25 pounds of linters, motes, and hulls were mixed with pink bollworm infested seed and run through fans. In one series of tests a Lummus dual fan with 10 blades was operated at 2450 RPM, and in another series a Continental No. 35 single fan was operated at 2300 RPM. Some of the long-cycle larvae in seed survived the former, but none survived the latter treatment.

Biology Studies of the Pink Bollworm (M. J. Lukefahr, Jack Sherrer, J. A. Griffin, and L. W. Noble): In a study of the time of day eggs are deposited, it was found that approximately 90 percent were deposited during the hours from 8:00 p.m. to 12:00 midnight with the peak near 9:00 p.m.

The incubation period at constant temperatures was as follows: 60° F. 15 days, 70° F. 11 days, 80° F. 5 days, 85° F. 4 days, and 90° F. 3 days. During summer months under insectary conditions, eggs usually hatched during the morning of the fourth day.

Of 3,204 larvae observed during these studies, 54.8 percent were females.

Larvae feeding on young squares required a slightly longer developmental period than those reared on older squares.

At constant temperatures the pupal period was approximately 8 days at 80, 85, 90, and 100° F., but at 70° F. it was 16 days and at 60° F. the pupal period was 29 days. Under insectary conditions the pupal period averaged 8 days.

In determining the time of day moths emerged from the pupal stage, it was observed that 75 percent emerged before 7:00 a.m. and 25 percent from 7:00 a.m. to 5:00 p.m.

Adults lived about 6 to 8 days after emerging from the pupal stage. The longevity of the male and female was about the same. The preoviposition period was about 3 days, with about 60 percent of the moths reared on squares or from the overwintering brood depositing eggs while 82 percent of the moths reared on bolls deposited eggs. The average number of eggs per female was as follows: From overwintering brood, 42.6; reared on squares, 27.6; and from moths reared on bolls, 69.2 eggs. The females reared on bolls appear to be highly fertile and they lay a large number of eggs.

Large adults frequently develop from pupae held at low temperatures, but these moths did not live appreciably longer nor deposit more eggs than average sized moths.

The age of bolls in which larvae were reared did not affect the length of the developmental stage, but it did affect the place of pupation and percentage of long-cycle larvae, as shown in the following table:

Boll age (Days)	Percent long-cycle larvae	Percent short-cycle larvae	
		Leaving bolls	Pupating in bolls
1-10	8.2	66.2	33.8
11-20	14.8	72.5	27.5
21-30	26.7	46.1	53.9
31-40	43.9	14.8	85.2
41-50	64.8	0.0	100.0

The high percentage of long-cycle larvae developing from old bolls is of particular significance. Likewise, it is interesting that some long-cycle larvae developed in bolls that were 10 days or less old when infested.

Airplane Collections (P. A. Glick and Arthur Gieser): To determine the height pink bollworm moths fly, a Piper Cub plane equipped with screen traps was used during the period, August 18 - September 3. Four flights were usually made each day at varying times from 5:00 a.m. to 10:00 p.m. In 46 flights, 10-minute exposures were made 239 times at heights ranging from 100 to 5,000 feet. The plane was flown at 50 miles per hour while the collections were being made.

There were 37 flights in the cotton growing area between Brownsville and Harlingen, and 9 over the King Ranch. The nearest cotton to this area was about 15 miles.

There were 12 pink bollworm moths collected at different altitudes as follows:

Height (feet)	Number caught	Sex
100	4	1 male, 3 females
200	3	1 male, 2 females
500	2	1 male, 1 female
1,000	3	1 male, 1 female, 1 undetermined

One moth was taken over the King Ranch at 1,000 feet above the ground.

Light Traps (P. A. Glick, W. J. Eitel, J. P. Hollingsworth): Light trap studies are being continued to learn more about the nocturnal activities of the moth and the possible use of traps in detecting infestation and control.

In one trap 100 feet above the ground on the El Jardin Hotel, 149 moths were caught in August and 80 in September. None was caught on top of the lighthouse at Port Isabel, 85 feet above ground. This trap was several miles from the nearest cotton.

Light traps were used at approximately 15 locations in Texas, Oklahoma, and New Mexico during July, August, and September. Moths were collected at all locations where infestations were known to occur. It appears that light traps may be effectively used as a research tool.

One light trap in a 40x60-foot cage did not control a pink bollworm infestation on cotton. In tests with a small number of traps at Brownsville the results were not encouraging. Eleven farmers at Batesville, Tex. used 77 light traps for field control involving a few thousand acres of cotton. On one farm with 600 acres of cotton 41 traps were operated. The infestation in these fields was much lower than in some other fields in that area where traps were not used. Further tests should be conducted before reaching conclusions.

Seven light traps were operated at heights of 2, 4, 6, 8, 10, 12, and 14 feet above the ground. It was found that the nearer the trap to the ground the greater the catch of moths. Forty percent of the moths were caught in a trap at the 2-foot level, and only 28 percent in the traps above 6 feet. Of the 29,670 moths collected in this study, 81 percent were males and 19 percent females.

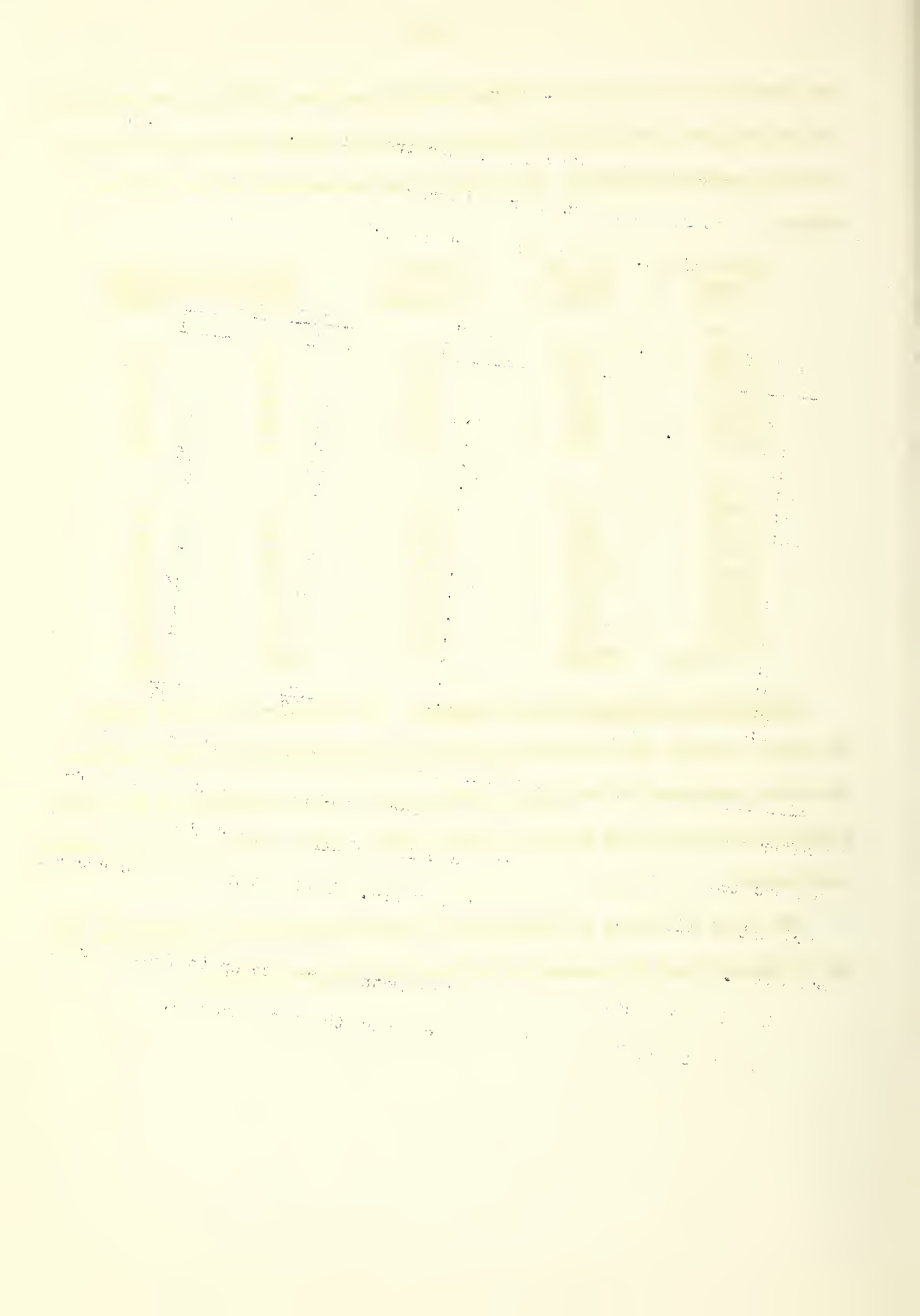
An experiment was conducted during July to determine the time of night pink bollworm moths were flying. A trap equipped with a black light

and suction fan was operated during six nights from 8:00 p.m. to 6:00 a.m. The collections were removed each hour and the number and sex of the pink bollworm moths determined. The results are summarized in the following table:

Time of night	No. of moths	Percent of total	Sex ratio percent	
			male	female
PM				
8:00	103	1.3	79	21
9:00	470	5.9	56	44
10:00	503	6.3	48	52
11:00	580	7.3	45	55
12:00	664	8.3	44	56
AM				
1:00	805	10.1	49	51
2:00	934	11.7	56	44
3:00	1584	19.9	84	16
4:00	1634	20.5	86	14
5:00	471	5.9	81	19
5:30	202	2.4	73	27
6:00	23	0.3	70	30
Total	7973		67	33

Mechanical Equipment (C. N. Husman): The samples of cotton before and after cutting with the two horizontal-rotary-blade type stalk cutter-shredders mentioned in the report (Page 10) of work conducted by the Texas Experiment Station were caged at Brownsville. Daily moth emergence records were taken.

The kill of larvae as indicated by moth emergence up to September 25 was 57 percent and 75 percent in the case of the two machines.



PUBLICATIONS

(Either not listed in Pink Bollworm Information No. 1 or listed without giving exact publication title and source)

"Defoliation as a Means of Cotton Insect Control" by F. C. Bishopp (Proceedings of the Eighth Annual Beltwide Cotton Defoliation Conference, Memphis, Tenn., Jan. 14-15, 1954, National Cotton Council, pp 65-66).

"Experiments on Hibernation of the Pink Bollworm in Texas and Oklahoma, 1952-53" by A. J. Chapman and L. W. Noble (USDA, ARS, Entomology Research Branch, E-879, May 1954).

"Mixtures of DDT and Other Insecticides for Control of Pink Bollworms and Boll Weevils in Southern Texas" by G. L. Smith, C. A. Richmond, and L. W. Noble (Jour. of Econ. Ent. 47 (1), Feb. 1954, pp 177-178).

"More Research Needed on Pink Bollworm" by F. C. Bishopp (The Cotton Ginners' Journal - Yearbook 1954, 22 (1), pp 52-54).

"New Weapons Sought in Pest Battle" by F. C. Bishopp (The Cotton Trade Journal, July 28, 1954).

"Status of Pink Bollworm Research" by F. C. Bishopp (Proceedings of Assoc. of Southern Agr. Workers, 51st Annual Convention, Dallas, Texas, Feb. 1954, p 103).

"Response of the Pink Bollworm Moth to Certain Ultraviolet and Visible Radiation" by Perry A. Glick and J. P. Hollingsworth (Jour. of Econ. Ent. 47 (1), Feb. 1954, pp 81-86).

"The Pink Bollworm Problem and Research Developments" by F. C. Bishopp (The Donna News, Aug. 20, 1954).

"The Relation of Insecticides to Insect Populations in Cotton Fields" by P. A. Glick and W. B. Lattimore (Jour. Econ. Ent. 47 (4), Aug. 1954, pp 681-684).

"The Pink Bollworm of Cotton in Texas" by F. A. Fenton and W. L. Owen, Jr. (Miscel. Publication 100, Texas Agr. Exper. Sta., Aug. 10, 1953).

"Guide for Controlling Cotton Insects in Texas, 1954" (Texas Extension Circular C-182, Revised).

"Ways to Fight the Pink Bollworm" (Texas Extension Circular C-319, 1954).

Talks and News Items

"Pink Bollworm Cooperative Research Program" by F. C. Bishopp (talk presented before Cotton and Cottonseed Advisory Committee Meeting, El Paso, Texas, Sept. 27-28-29 - not to be published).

"Results of New Research That May Affect Control Program" by F. C. Bishopp (talk presented before Beltwide Pink Bollworm Committee Meeting, Dallas, Texas, Sept. 23-24 - not to be published).

Several informal talks were made before Civic and other groups by members of the staff.

A number of news items regarding visiting groups and the status of the pink bollworm research and its application to local conditions were carried in south Texas newspapers and on radio and television.

PERSONNEL

Name	Title	Assignment
F. C. Bishopp	Coordinator, Pink Bollworm Research	
	BROWNSVILLE, TEXAS	
S. E. Jones	Entomologist	In administrative and technical charge of Brownsville laboratory and sub-laboratories and in technical charge of all pink bollworm research conducted in the Southwest by the Cotton Insects Section
A. J. Chapman	Entomologist	Assistant in charge
E. W. Clark	Entomologist	Physiological, morphological, histological, nutritional, biochemical research
D. S. Chadbourne	Entomologist	Physiological, morphological, histological, nutritional, biochemical research
D. H. Currie	Cotton Technologist	Gin equipment in relation to pink bollworm
W. J. Eitel	Entomologist	Light trap investigations
P. A. Glick	Entomologist	Light trap investigations
C. N. Husman	Equipment Engineer	Designing, adapting, and maintenance of equipment
W. L. Lowry	Entomologist	Toxicology laboratory tests
M. J. Lukefahr	Entomologist	Pink bollworm biology studies
R. L. McGarr	Entomologist	Insecticides, field inspections, and other program duties
J. M. McGough	Entomologist	Pink bollworm parasites
Don Morris	Writer	Intermittent work on manuscripts
L. W. Noble	Entomologist	Reports and research program duties
E. L. LaPierre	Clerk-Typist	Clerical
C. A. Richmond	Entomologist	Insecticides and field inspections
Ivan Shiller	Entomologist	Insecticides, hibernation experiments, host plants, and varietal susceptibility to pink bollworm attack
E. O. Schunter	Clerk-Typist	Clerical
M. A. Taylor	Adm. Assistant	Fiscal administrative
C. H. Tsao	Entomologist	Toxicology laboratory tests
O. L. Walton	Entomologist	Ginning studies, insecticides and herbicides
F. B. Weeks	Clerk-Typist	Clerical
J. C. Gonzalez	Laborer--Unalloc.	Labor as assigned
	COLLEGE STATION, TEXAS	
E. S. Vanderzant (Part-time)	Biochemist	Nutrition, artificial rearing media

LUBBOCK, TEXAS

Name	Title	Assignment
O. T. Robertson	Entomologist	In charge of sublaboratory, hibernation experiments, light trap investigations and ginning studies
J. W. Davis	Entomologist	Hibernation experiments, light trap investigations and insecticide experiments

PORT LAVACA, TEXAS

G. L. Smith	Entomologist	In charge of sublaboratory, hibernation and insecticide experiments, host plant studies
T. P. Cassidy (Part-time)	Entomologist	Ecology

WACO, TEXAS

C. R. Parencia	Entomologist	Hibernation

TORRECN, COAH., MEXICO

C. S. Rude	Entomologist	Insecticide experiments and studies of pink bollworm infestation level in the area.

PERSONNEL ASSIGNED BY STATES

Alabama

J. A. Griffin	Entomologist (Brownsville)	Insecticide experiments

Arkansas

J. D. Sherrer	Entomologist (Port Lavaca)	Insecticide experiments
B. R. Jones (Part-time)	Field Aid (Port Lavaca)	Insecticide experiments

Texas

Name	Title	Assignment
J. C. Gaines (Part-time)	Entomologist	Head, Dept. of Entomology
W. J. Magee	Entomologist	Insecticides, sprayers, dusters, stalk cutters, growth inhibitors, production practices
M. G. Davenport	Agricultural Engineer	Sprayers, dusters, stalk cutters, production practices
S. P. Johnson (Part-time)	Plant Pathologist	Plant growth inhibitors, production practices
J. R. Brazzel (Part-time)	Entomologist	Plant resistance
G. P. Wene (Part-time)	Entomologist (Weslaco)	Insecticides, sprayers, dusters, stalk cutters

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